

CLAIMS

1. A three-dimensional pointing method for pointing at a desired point in a three-dimensional space represented on a display apparatus based on two-dimensional coordinates of a position that is pointed at by a pen tip of an input pen on a predetermined detection plane and based on pen pressure that is pressure applied to the pen tip of the input pen, comprising the step of:

changing a depth direction coordinate of a three-dimensional pointer to be displayed in the three-dimensional space according to the pen pressure of the input pen, and displaying the three-dimensional pointer.

2. A three-dimensional pointing method for pointing at a desired point in a three-dimensional space represented on the display apparatus based on two-dimensional coordinates of a position that is pointed at by a pen tip of an input pen on a predetermined detection plane, pen pressure that is pressure applied to the pen tip of the input pen, an inclination angle that is an angle between an axis of the input pen and the detection plane, and a direction angle that is an angle between a projection of the axis of the input pen onto the detection plane and a predetermined line on the detection plane, comprising the steps of:

obtaining an extension of the axis of the input pen in the three-dimensional space based on the inclination angle and the direction angle of the input pen;

displaying a three-dimensional pointer on

the extension in the three-dimensional space; and
changing a coordinate of a three-
dimensional pointer in the direction of the
extension in the three-dimensional space according
5 to the pen pressure of the input pen, and displaying
the three-dimensional pointer.

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3. A three-dimensional pointing method for
pointing at a desired point in a three-dimensional
space represented on the display apparatus based on
two-dimensional coordinates of a position that is
15 pointed at by a pen tip of an input pen on a
predetermined detection plane, and based on time for
continuing to point or operation of an operation
means provided in the input pen, comprising the step
of:

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changing a depth direction coordinate of a
three-dimensional pointer to be displayed in the
three-dimensional space according to the time for
continuing to point with the pen tip of the input
pen or the operation of the operation means of the
25 input pen, and displaying the three-dimensional
pointer.

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4. A three-dimensional pointing method for
pointing at a desired point in a three-dimensional
space represented on the display apparatus based on
two-dimensional coordinates of a position that is
35 pointed at by a pen tip of an input pen on a
predetermined detection plane, time for continuing
to point or operation of an operation means provided

in the input pen, an inclination angle that is an angle between an axis of the input pen and the detection plane, and an direction angle that is an angle between a projection of the axis of the input
5 pen onto the detection plane and a predetermined line on the detection plane, comprising the steps of:

obtaining an extension of the axis of the input pen in the three-dimensional space based on
10 the inclination angle and the direction angle of the input pen;

displaying a three-dimensional pointer on the extension in the three-dimensional space; and
changing a coordinate of a three-
15 dimensional pointer in the direction of the extension in the three-dimensional space according to the time for continuing to point with the pen tip of the input pen or according to the operation of the operation means of the input pen, and displaying
20 the three-dimensional pointer.

25 5. The three-dimensional pointing method as claimed in any one of claims 1-4, wherein it is determined that an object is pointed at when the object exists within a predetermined distance from three-dimensional coordinates of a point at which
30 the three-dimensional pointer points.

35 6. The three-dimensional pointing method as claimed in any one of claims 1-4, wherein, when an object displayed in the three-dimensional space

is pointed at with the three-dimensional pointer, if operation for selecting or holding the object is performed,

the three-dimensional position of the
5 object is changed according to change of the three-dimensional position of the three-dimensional pointer after the operation for selecting or holding the object is performed, and the object is displayed.

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7. The three-dimensional pointing method as claimed in any one of claims 1-4, wherein, when
15 an object displayed in the three-dimensional space is pointed at with the three-dimensional pointer, if operation for starting to operate, edit or process the object is performed,

the object that is pointed at is displayed
20 two-dimensionally on a plane, of the display apparatus, that is closest to an operator, and

the two-dimensionally displayed object accepts the two-dimensional operation, editing, or processing by the input pen.

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8. The three-dimensional pointing method
30 as claimed in any one of claims 1-3, wherein the two-dimensional coordinates of the position at which the pen tip of the input pen points on the detection plane is regarded as two-dimensional coordinates of the point at which the three-dimensional pointer
35 points, and the depth direction coordinate of the three-dimensional pointer is changed while keeping the two-dimensional coordinates of the point at

which the three-dimensional pointer points to be constant.

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9. A three-dimensional pointing apparatus for generating a pointer based on two-dimensional coordinates of a position that is pointed at by a pen tip of an input pen on a predetermined detection plane and based on pen pressure that is pressure applied to the pen tip of the input pen, and displaying the generated pointer at a desired point in three-dimensional space represented on a display apparatus to perform pointing, comprising:

10 input information obtaining means for obtaining information of the two-dimensional coordinates and the pen pressure of the input pen; pointer position/rotation angle

20 calculation means for calculating a position and an rotation angle of the pointer to be displayed in the three-dimensional space represented on the display apparatus based on the information obtained by the input information obtaining means;

25 pointer generation means for generate the pointer based on the calculation result of the pointer position/rotation angle calculation means; pointing determination means for determining whether there is an object that is

30 pointed at by the pointer generated by the pointer generation means in the three-dimensional space represented on the display apparatus;

object generation means for generating the object to be displayed in the three-dimensional

35 space represented on the display apparatus; and display control means for displaying the pointer generated by the pointer generation means

and the object generated by the object generation means in the three-dimensional space represented on the display apparatus,

wherein the pointer position/rotation
5 angle calculation means changes a depth direction coordinate of the three-dimensional pointer to be displayed in the three-dimensional space according to the pen pressure of the input pen in the calculation.

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10. A three-dimensional pointing apparatus
15 for generating a pointer based on two-dimensional coordinates of a position that is pointed at by a pen tip of an input pen on a predetermined detection plane and based on time for continuing to point or operation of an operation means provided in the
20 input pen, and displaying the pointer at a desired point in a three-dimensional space represented on a display apparatus to perform pointing, comprising:

input information obtaining means for
obtaining information of the two-dimensional
25 coordinates of the input pen, and information of contact/noncontact status of the pen tip of the input pen or information of operation of an operation means of the input pen;

input information process means for
30 calculating the time for continuing to point with the pen tip of the input pen or an amount by which the operation means is operated based on the information obtained by the input information obtaining means;

35 pointer position/rotation angle calculation means for calculating a position of the pointer to be displayed in the three-dimensional

space represented on the display apparatus based on the information obtained by the input information obtaining means;

5 pointer generation means for generating the pointer based on the calculation result of the pointer position/rotation angle calculation means;

10 pointing determination means for determining whether there is an object that is pointed at by the pointer generated by the pointer generation means in the three-dimensional space represented on the display apparatus;

15 object generation means for generating the object to be displayed in the three-dimensional space represented on the display apparatus; and

20 display control means for displaying the pointer generated by the pointer generation means and the object generated by the object generation means in the three-dimensional space represented on the display apparatus,

25 wherein the pointer position/rotation angle calculation means performs the calculation by changing a depth direction coordinate of the three-dimensional pointer to be displayed in the three-dimensional space according to the time for continuing to point or according to the operation of the operation means provided in the input pen.

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11. The three-dimensional pointing apparatus as claimed in claim 10, wherein the pointing determination means determines that an object is pointed at when the object exists within a predetermined distance from three-dimensional coordinates of a point at which the three-dimensional pointer points.

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5 12. The three-dimensional pointing
apparatus as claimed in claim 9 or 10, wherein the
object generation means comprising means for
changing the three-dimensional position of the
object according to change of the three-dimensional
10 position of the three-dimensional pointer to
generate the object, and
when an object displayed in the three-
dimensional space is pointed at with the three-
dimensional pointer, if operation for selecting or
15 holding the object is performed,
the three-dimensional position of the
object is changed according to change of the three-
dimensional position of the three-dimensional
pointer after the operation for selecting or holding
20 the object is performed, and the object is displayed.

25 13. The three-dimensional pointing
apparatus as claimed in claim 9, wherein, in
addition to the information of the two-dimensional
coordinates and the pen pressure, the input
information obtaining means obtains an inclination
30 angle that is an angle between an axis of the pen
and the detection plane, and an direction angle that
is an angle between a projection of the axis of the
input pen onto the detection plane and a
predetermined line on the detection plane, and
35 the pointer position/rotation angle
calculation means obtains an extension of the axis
of the input pen in the three-dimensional space

based on the inclination angle and the direction
angle of the input pen, sets a position of a three-
dimensional pointer to be on the extension in the
three-dimensional space, and performs the
5 calculation by changing a coordinate of the three-
dimensional pointer in the direction of the
extension in the three-dimensional space according
to the pen pressure of the input pen.

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14. The three-dimensional pointing
apparatus as claimed in claim 10, wherein, the input
15 information obtaining means obtains information of
an inclination angle that is an angle between an
axis of the pen and the detection plane, and
information of a direction angle that is an angle
between a projection of the axis of the input pen
20 onto the detection plane and a predetermined line on
the detection plane, and

the pointer position/rotation angle
calculation means obtains an extension of the axis
of the input pen in the three-dimensional space
25 based on the inclination angle and the direction
angle of the input pen, sets a position of a three-
dimensional pointer to be on the extension in the
three-dimensional space, and performs the
calculation by changing a coordinate of the three-
30 dimensional pointer in the direction of the
extension in the three-dimensional space according
to the time for continuing to point or the operation
of the operation means provided in the input pen.

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15. The three-dimensional pointing
apparatus as claimed in claim 8 or 10, wherein the
input information obtaining means further obtains
information of a rotation angle of the input pen
5 that is a rotation angle around the axis of the
input pen when pointing with the pen tip of the
input pen is performed on the detection plane, and
the pointer position/rotation angle
calculation means performs the calculation by
10 changing a rotation angle around the axis of the
three-dimensional pointer according to the rotation
angle of the input pen.

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16. The three-dimensional pointing
apparatus as claimed in claim 9 or 10, the object
generation means comprising means for, when an
20 object displayed in the three-dimensional space is
pointed at, if operation for starting to operate,
edit or process the object is performed, generating
an object that is a projection of the pointed object
at onto a plane, of the display apparatus, that is
25 closest to an operator.

30 17. The three-dimensional pointing
apparatus as claimed in claim 16, wherein, after the
object two-dimensionally displayed on the closest
plane accepts the two-dimensional operation, editing,
or processing with the input pen, when operation for
35 ending the operation, editing, or processing for the
object is performed, the object generation means
generates an object obtained by restoring the two-

dimensionally displayed object to a three-
dimensionally display state just before the
operation for starting the operation, editing or
processing is performed.

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18. The three-dimensional pointing
10 apparatus as claimed in claim 9, wherein the input
pen has a structure in which the length of the pen
tip is shortened according to the pen pressure, and
the three-dimensional pointer has a shape
similar to the pen tip of the input pen, or a shape
15 similar to a part of the pen tip.

20 19. The three-dimensional pointing
apparatus as claimed in claim 10, wherein the input
pen has a structure in which the length of the pen
tip is shortened according to the time for
continuing to point with the pen tip or according to
25 the operation of the operation means, and
the three-dimensional pointer has a shape
similar to the pen tip of the input pen, or a shape
similar to a part of the pen tip.

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20. The three-dimensional pointing
apparatus as claimed in claim 9 or 10, wherein the
35 pointer position/rotation angle calculation means
sets the two-dimensional coordinates of the point at
which the three-dimensional pointer points to be the

two-dimensional coordinates of the position at which the pen tip of the input pen points on the detection plane, and changes the depth direction coordinate of the three-dimensional pointer while keeping the two-dimensional coordinates of the point at which the three-dimensional pointer points to be constant.

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21. A three-dimensional pointing program for causing a computer to execute processes in each means of the three-dimensional pointing apparatus as claimed in any one of claims 9-20.

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22. A three-dimensional pointing method for moving a pointer, in a three-dimensional space, that is displayed in the three-dimensional space of a display apparatus that can represent the three-dimensional space, and pointing at a desired point in the three-dimensional space, comprising:

25 a step 1 of moving or rotating the pointer on a two-dimensional plane that is perpendicular to a depth direction of the three-dimensional space of the display apparatus, and moving the pointer in the depth direction;

30 a step 2 of moving a part for performing pointing in the pointer in the depth direction while keeping, to be constant, a depth direction position of a predetermined point of the pointer other than the part for performing pointing in the pointer, and
35 while keeping a shape and a size of the pointer to be constant, wherein the part for performing pointing in the pointer includes a point for

performing pointing and the neighborhood; and
a step 3 for causing the display apparatus
to display the pointer moved in the step 1 and the
step 2.

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23. The three-dimensional pointing method
10 as claimed in claim 22, wherein, in step 2, the
pointer is rotated around a predetermined center
point or center axis, wherein points on the surface
or the inside of the pointer are excluded for the
predetermined center point or the center axis.

15

24. A three-dimensional pointing method
20 for moving a pointer, in a three-dimensional space,
that is displayed in the three-dimensional space of
a display apparatus that can represent the three-
dimensional space, and pointing at a desired point
in the three-dimensional space, comprising:

25 a step 1 of moving or rotating the pointer
on a two-dimensional plane that is perpendicular to
a depth direction of the three-dimensional space of
the display apparatus, and moving the pointer in the
depth direction;

30 a step 4 of moving a part for performing
pointing in the pointer in the depth direction while
keeping a depth direction position of a
predetermined point of the pointer other than the
part for performing pointing in the pointer to be
35 constant, and while deforming a shape and a size of
the pointer; and

a step 3 for causing the display apparatus

to display the pointer moved in the step 1 and the step 4.

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25. The three-dimensional pointing method as claimed in claim 24, wherein, in step 4, the pointer is rotated around a predetermined center point or center axis, wherein points on the surface or the inside of the pointer are excluded for the predetermined center point or the center axis.

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26. The three-dimensional pointing method as claimed in claim 23 or 25, wherein the center point or the center axis around which the pointer is rotated moves according to a rotation angle when the pointer rotates.

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27. The three-dimensional pointing method as claimed in claim 24, the pointer comprising:
a first part in which the depth direction position, a position on the two-dimensional plane, the shape and the size are constant;
a second part in which at least the depth direction position changes; and
a third part for connecting the first part with the second part,
wherein, in the step 4, the second part of the pointer is moved in the depth direction.

28. The three-dimensional pointing method
5 as claimed in claim 27, wherein, in the step 4, the
second part is moved in the depth direction while
changing the position of the second part in the two-
dimensional plane, or a shape of the second part, or
10 a size of the second part of the three-dimensional
pointer.

29. The three-dimensional pointing method
15 as claimed in any one of claims 22-28, wherein, when
a part of the pointer lies off the three-dimensional
space that can be represented by the display
apparatus when the pointer moves in the depth
20 direction, the lain-off part is projected onto a
two-dimensional plane, of two-dimensional planes
that can be represented by the display apparatus,
that is close to the lain-off part, or the lain-off
part is bent, so as to display the part.

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30. The three-dimensional pointing method
30 as claimed in any one of claims 22-28, wherein, in
step 3, the display apparatus is caused to display a
reference pointer, with the pointer, in which the
depth direction position is constant.

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31. A three-dimensional pointing apparatus for displaying a pointer in a three-dimensional space represented on a display apparatus that can represent the three-dimensional space, moving the
5 pointer three-dimensionally based on input information from an input apparatus, and pointing at an arbitrary point in the three-dimensional space, comprising:
input information obtaining means for
10 obtaining input information from the input apparatus;
pointer position/deformation amount calculation means for calculating a display position and a deformation amount of the pointer based on the
15 input information obtained by the input information obtaining means;
pointer generation means for generating a pointer to be displayed at the display position calculated by the pointer position/deformation
20 amount calculation means;
pointing determination means for determining whether there is an object at a point at which the pointer points based on the display position calculated by the pointer
25 position/deformation amount calculation means;
object generation means for changing the object to a state indicating that the object is pointed at when it is determined that there is the object that is pointed at in the pointing
30 determination means; and
display control means for causing the display apparatus to display the pointer generated by the pointer generation means and the object generated by the object generation means.

32. The three-dimensional pointing apparatus as claimed in claim 31, the pointer generation means comprising means for moving a part
5 for performing pointing in the pointer in the depth direction while keeping a depth direction position of a predetermined position of the pointer other than the part for performing pointing in the pointer, to be constant, and while keeping a shape and a size
10 of the pointer to be constant, wherein the part for performing pointing includes a point for performing pointing and the neighborhood.

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33. The three-dimensional pointing apparatus as claimed in claim 31, the pointer generation means comprising means for moving a part
20 for performing pointing in the pointer in the depth direction while keeping a depth direction position of a predetermined position of the pointer other than the part for performing pointing in the pointer to be constant, and while deforming a shape and a
25 size of the pointer.

30 34. The three-dimensional pointing apparatus as claimed in claim 32 or 33, wherein the means for moving the part for performing pointing in the pointer in the depth direction rotates the pointer around a predetermined center point or
35 center axis, wherein points on the surface or the inside of the pointer are excluded for the predetermined center point or the center axis.

5 35. The three-dimensional pointing
apparatus as claimed in claim 31, the pointer
generation means comprising:

 means for dividing the pointer into a
first part in which the depth direction position, a
10 position on the two-dimensional plane, the shape and
the size are constant, and a second part in which at
least the depth direction position changes, and for
moving only the second part in the depth direction;
and

15 means for connecting the first part with
the second part after moving the second part in the
depth direction.

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 36. The three-dimensional pointing
apparatus as claimed in any one of claims 31-35, the
pointer generation means comprising:

25 means for determining whether a part of
the pointer lies off the three-dimensional space
that can be represented by the display apparatus
when the pointer moves in the depth direction; and

 means for, when there is the lain-off part,
30 projecting the lain-off part onto a two-dimensional
plane, of two-dimensional planes that can be
represented by the display apparatus, that is close
to the lain-off part, or bending the lain-off part.

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37. A three-dimensional pointing program for causing a computer to execute processes in each means of the three-dimensional pointing apparatus as claimed in any one of claims 31-36.

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38. A three-dimensional display control method for controlling display states of a pointer and one or more objects, when displaying the pointer and one or more objects in a three-dimensional space represented on a display apparatus that can represented the three-dimensional space, moving the pointer three-dimensionally based on input information from an input apparatus, and pointing at an arbitrary point in the three-dimensional space, comprising:

20 a step 1 of calculating a display position of the pointer based on the input information;

a step 2 of displaying the pointer at the display position calculated in the step 1; and

25 a step 3 of determining whether there is an object in the front side of the depth position of the pointer based on the display position of the pointer calculated in the step 1, and transparentizing the object in the front side of the depth position of the pointer and displaying the object.

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39. The three-dimensional display control method as claimed in claim 38, wherein, in step 3, only an object, of objects located in the front side of the depth position of the pointer, that overlaps

with the pointer is transparentized and displayed.

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40. The three-dimensional display control method as claimed in claim 38 or 39, the step 3 comprising:

transparentizing and displaying an object
10 of the objects located in the front side of the depth position of the pointer, from which objects that are specified or selected based on predetermined input information received from the input apparatus are excluded.

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41. The three-dimensional display control
20 method as claimed in claim 39, the step 3 comprising:

changing transparency of an object
according to depth direction distance between the object located in the front side of the depth
25 position of the pointer and the pointer so as to increase the transparency as the depth direction distance between the object and the pointer becomes larger.

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42. The three-dimensional display control method as claimed in claim 39, the step 3
35 comprising:

transparentizing only a region within a predetermined shape having a center point, on the

object, that overlaps with a point at which the pointer point, and displaying the object

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43. The three-dimensional display control method as claimed in claim 42, wherein the predetermined shape to be transparentized changes
10 according to the depth direction distance between the pointer and the object, such that the larger the depth direction distance is, the larger the predetermined shape.

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44. The three-dimensional display control method as claimed in claim 38 or 39, the step 3
20 comprising:

a step of, when the pointer stands still for a predetermined time, restoring the transparentized object to the opaque state that is a state before being transparentized, and displaying
25 the object.

30 45. A three-dimensional display control apparatus for controlling display states of a pointer and one or more objects, when displaying the pointer and one or more objects in a three-dimensional space represented on a display apparatus
35 that can represented the three-dimensional space, moving the pointer three-dimensionally based on input information from an input apparatus, and

pointing an arbitrary point in the three-dimensional space, comprising:

5 input information obtaining means for obtaining input information from the input apparatus;

 pointer position calculation means for calculating a display position of the pointer based on the input information obtained by the input information obtaining means;

10 pointer generation means for generating a pointer to be displayed at the display position calculated by the pointer position calculation means;

 object change determination means for
15 determining whether there is an object in the front side of the depth position of the pointer based on the display position of the pointer calculated by the pointer position calculation means, and determining whether to transparentize the object in
20 the front side of the depth position of the pointer;

 object generation/transparentizing means for generating the object to be displayed on the display apparatus and transparentizing the object that is determined to be transparentized by the
25 object change determination means; and

 display control means for causing the display apparatus to display the pointer generated by the pointer generation means or the object transparentized by the object
30 generation/transparentizing means.

35 46. The three-dimensional display control apparatus as claimed in claim 45, the object change determination means comprising:

means for determining whether there is an object, of the objects located in the front side of the depth position of the pointer, that is specified or selected based on predetermined input information
5 from the input apparatus, and

wherein the object change determination means causes the object generation/transparentizing means to transparentize objects from which the specified object is excluded.
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47. The three-dimensional display control apparatus as claimed in claim 45 or 46, the object generation/transparentizing means comprising:
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means for calculating depth direction distance between the pointer and the object to be transparentized, and
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wherein the object generation/transparentizing means changes the transparency of the object to be transparentized according to the depth direction distance.
25

48. The three-dimensional display control apparatus as claimed in claim 45 or 46, the object generation/transparentizing means comprising:
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means for calculating a point that overlaps with a point, on the object to be transparentized, at which the pointer points, and
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wherein the object generation/transparentizing means transparentizes only a region within a predetermined shape having the calculated point as a center.

5 49. The three-dimensional display control
apparatus as claimed in claim 45 or 46, the object
change determination means comprising:
 means for determining whether the pointer
stands still for a predetermined time, and
10 wherein, when the pointer stands still for
the predetermined time, the object change
determination means causes the object
generation/transparentizing means to restore the
transparentized object to the opaque state before
15 being transparentized.

20 50. A three-dimensional pointing program
for causing a computer to execute processes in each
means of the three-dimensional display control
apparatus as claimed in any one of claims 45-49.

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